




LLNL Clean Energy Technologies for Commercialization



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Breakthrough Technology

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- “Breakthrough” technologies are those inventions that represent entirely new ways of doing well-understood tasks or doing things not previously imagined.
 - “Breakthrough” technologies in the hands of entrepreneurs often disrupt existing markets or even create new ones and generate significant value. These are the “game-changers” that drive our economy.
 - In a “hot, flat and crowded” world, high-throughput creation and commercialization of breakthrough technologies is key to the energy, economic and national security of the United States.
 - LLNL has a history of creating breakthrough technologies that have had disruptive, game-changing applications:

Breakthrough Technology

First Satellite Imagery



- Walter Scott, LLNL scientist on SDI, founded Worldview Imaging which became Digital Globe
- Digital Globe became the first high resolution imagery provider.
- Digital Globe is today the high resolution imagery provider to Google Earth and the National Geospatial-Intelligence Agency.

Chromosome Painting



- A discovery from early flow cytometry and human genome research.
- The technique enabled rapid detection and marking of chromosomal abnormalities.
- Imagenetics Inc. lead to Vysis, Inc and it was sold to Abbott and is used for screening and diagnosis and recurrence monitoring for cancer.



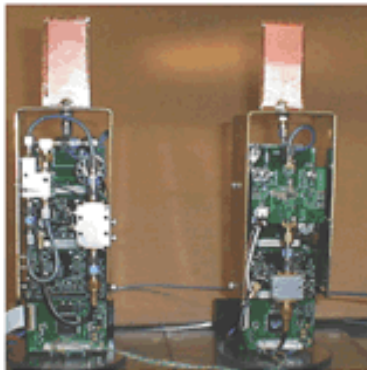
Breakthrough Technology

Rapid DNA Analysis



- Breakthroughs in applied instrumentation at LLNL led to core technologies that make PCR for genetic applications possible in 30 minutes.
- This was licensed to Cepheid in 1997 where it is used to perform a broad array of tests from identifying infectious organisms to early detection of disease.

Micro-Impulse Radar



- MIR was invented in 1993 using UWB spectrum.
- MIR makes possible extremely accurate systems for motion detection and localization,
- MIR is licensed non-exclusively in automotive backup detectors, bridge and road wear monitoring, search and rescue applications and non-invasive medical diagnostics



What's in the Pipeline at LLNL



■ Licensed Technologies and existing collaborative work

- Carbon Fuel Cell
- Zinc/Air Fuel Cell
- Energy efficient CNT desalinization technology
- Reactive Nanofoils
- CO2 Sequestration

■ Technologies in development (1-2 years)

- Wind energy forecasting for placement of wind power generators
- New technology for distributed solar thermal power
- Lower cost electromechanical batteries
- High energy density nanolaminate capacitors for hybrid vehicles

■ Emerging technologies (3-5 years)

- Stronger storage tanks for hydrogen fuel vehicles
- More efficient biofuel engine
- New Li Batteries
- Thermoelectric materials
- Improved HCCI engine

3-5 yrs

1-2 yrs

Small company interest

Licensed

Collaboration

LLNL Advanced Solid State Lithium – Ion Battery

- Ultimately, a new inherently safe, high-energy, high-rate solid-state rechargeable battery could be fabricated as a composite solid-state material (LLNL proprietary technology)
- This achievement would provide the first robust solid-state rechargeable battery for various applications, and would double the mission duration possible with the best commercially available polymer-gel technology and increase by 10X the duration possible with existing SPE-type cells.



- Lithium-ion explosions and fires occur frequently in both products and plants:
- Safety issues limit
- introduction of higher energy materials
- A 100 mi range EV battery has energy of 460 sticks of dynamite
- Statistics predict 1 in every 28,000 EVs will burn and/or explode
- There are important implications for U.S. defense applications

Electromechanical Battery Technology

It's Different:

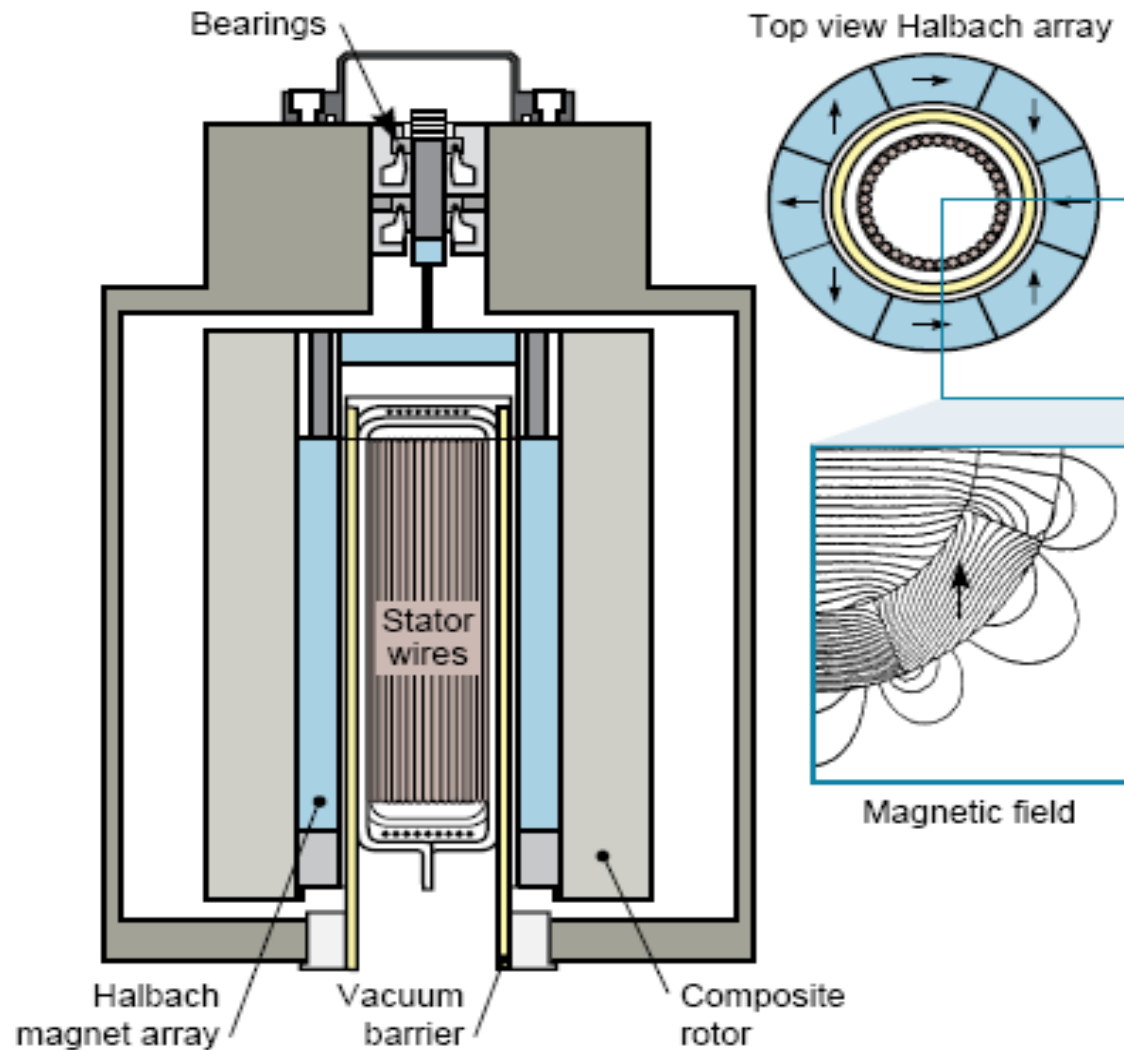
E-S Motor



Passive Bearings

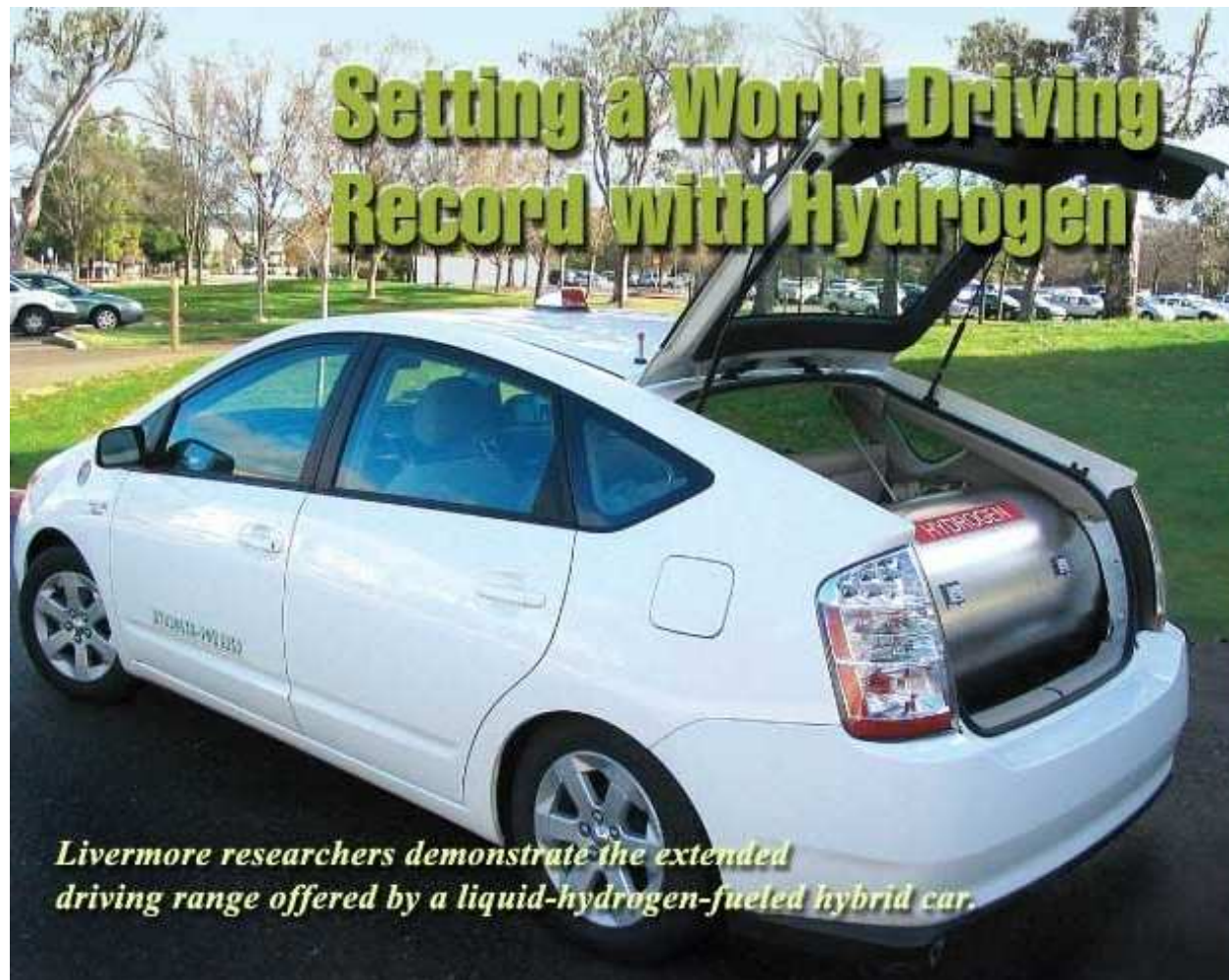


Composite Rotor



source: Lawrence Livermore National Laboratory

LLNL Pressurized Hydrogen Fuel Tank car holds the Guinness World Record for number of miles on a single tank of hydrogen



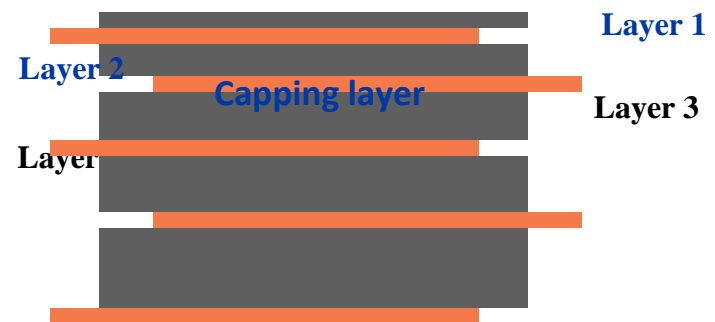
High Energy Density Capacitors

LLNL technology

- Reproducible at very high accuracy.
- High energy density storage in tiny footprint opens up the potential for clean technologies
- Power control in a small space

Applications:

- Increase the range of hybrid vehicles
- Snubber capacitors save energy in power systems



Solar Thermal Heat Engine

LLNL approach

- Collector: size of satellite dish
- Stored surplus energy allows a recalculation of solar power economics, a competitive return on investment is possible
- Uses new heat engine
- Distributed energy generation

Applications

- Distributed power grid
- Residential
- Light industry

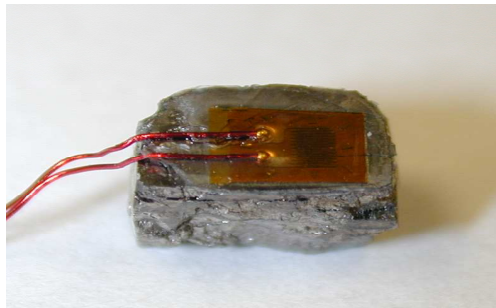


More New Breakthroughs



Passive Magnetic levitation for Cargo

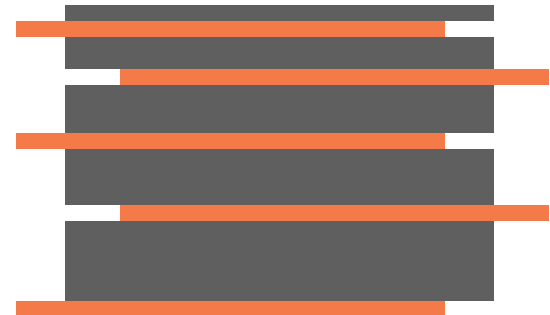
- Propulsion with minimal energy
- Passive magnetic fields
- Cargo and passenger applications



Thermoelectric Material

Reproducible at very high accuracy.

High energy density storage in tiny footprint opens up the potential for clean technologies



Routinizing Innovation

Technology and field	Business plan completed	Technical plan completed	Maturation funding from:	Maturation Project
Electro-Mechanical storage	April 09	June 09	optionee	July 09
Electro-Mechanical Vehicle	January 09	July 09	Optionee	September 09
Solar Thermal	November 08	May 09	Optionee	August 09
Ultra Capacitors	February 09	July 09	Partner	September 09
MagLev Ports	October 08	December 08	Optionee	August 09
H2 in CNT	February 09	In process	Partner	FY10
Solid State Li Battery	May 09	In process	Optionee	FY10

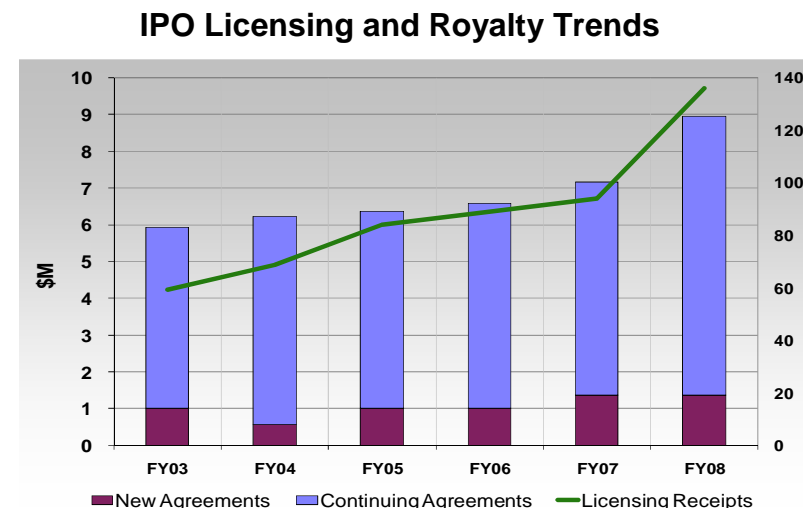
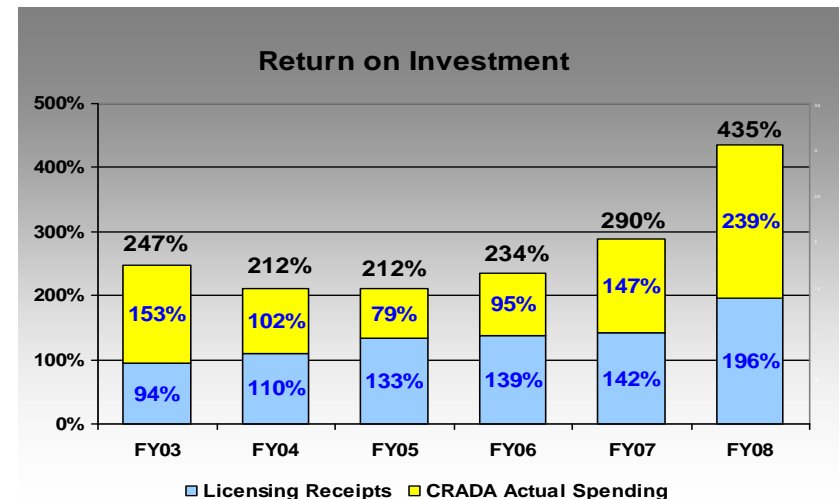
How Are We Doing?

We're returning \$4.35 for every dollar invested in IPO

Last year we earned more in licensing income (L&R) than any other DOE Lab – ever.

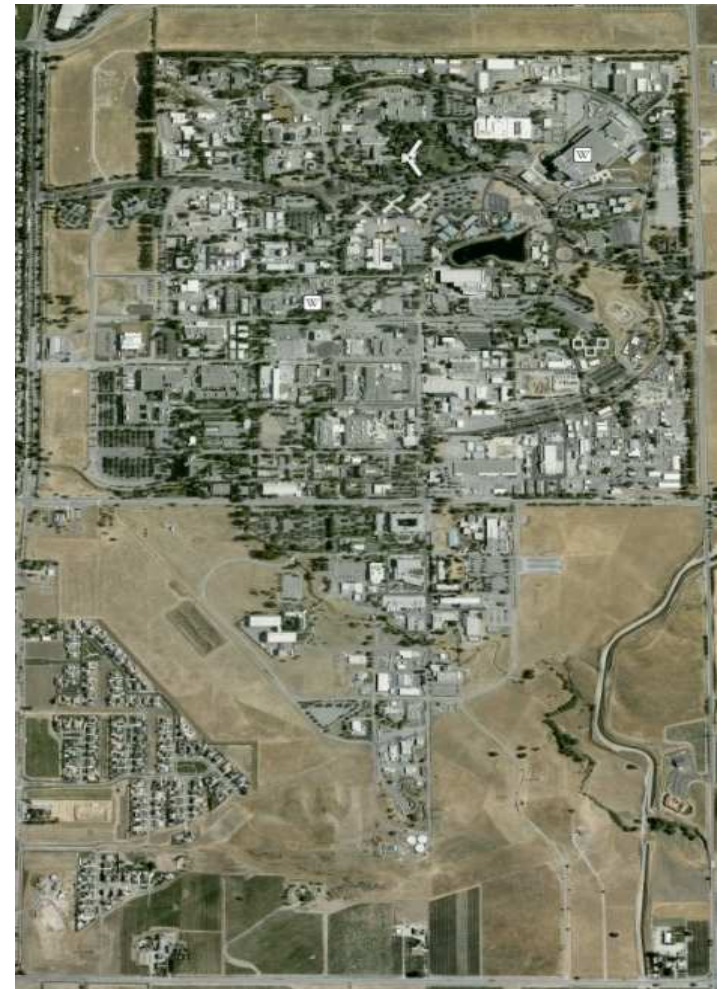
In FY09, we were able to provide the initial \$10M to help launch LLNL's initiatives.

License revenues reflect roughly \$500 million in annual revenues and ~3,500 jobs to US companies

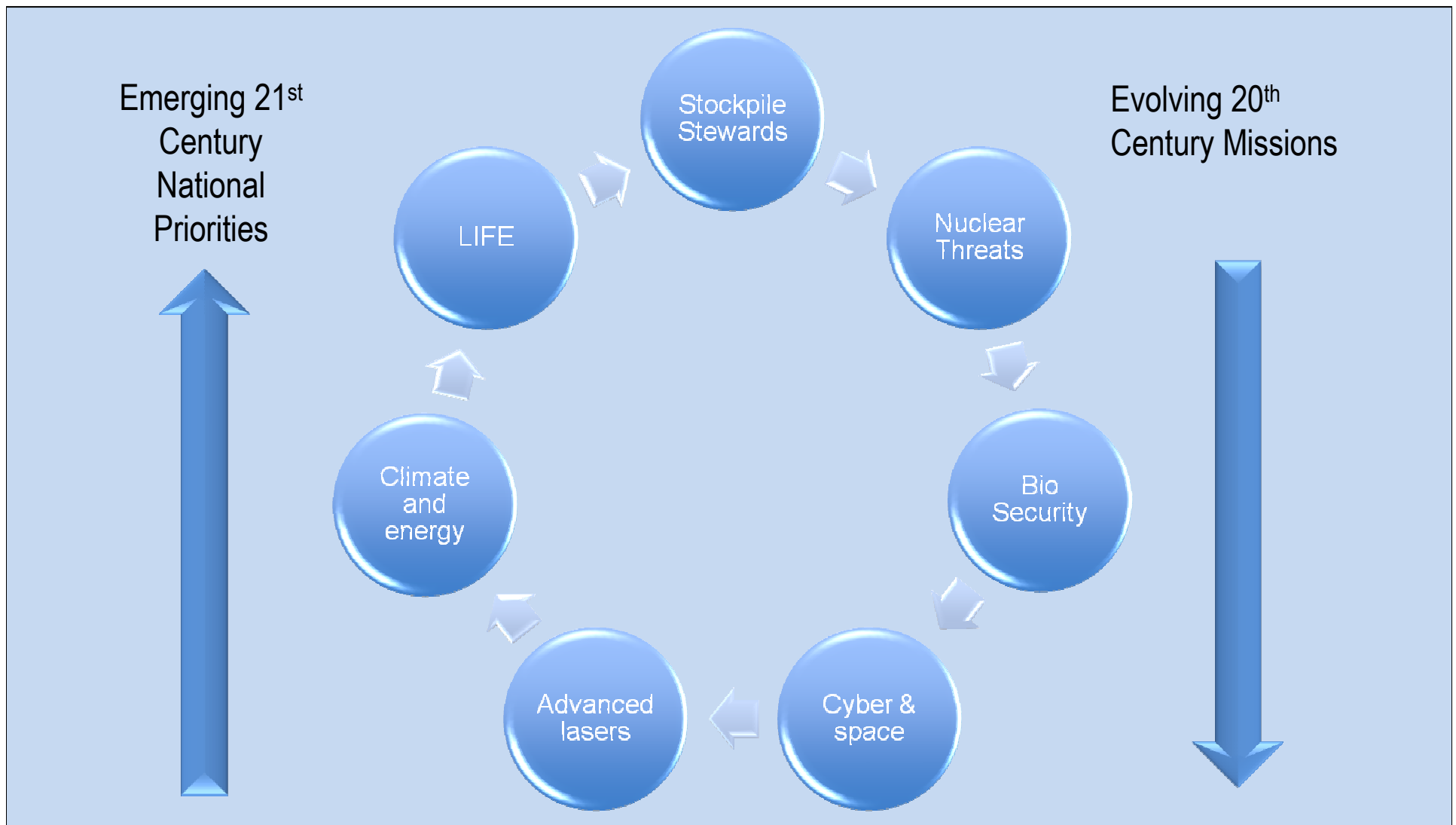


New Mechanisms to Commercialize Breakthrough Technology

- Open Access at LVOC
- IP Auction
- Entrepreneurs-in-Readiness
- University Entrepreneurship Centers
- Cost-shared prototyping
- Entrepreneurial Separation
- Industrial Advisory Board
- Foundations
- New Venture Accelerator



The Source of Future LLNL "Inventions"



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